Team 19, JAGS Soap, is composed of four senior chemical engineers. The team designed and optimized a soap production plant. The project was prompted by the increased global demand for sanitary products, instigated specifically by the COVID-19 pandemic.

Traditional soap making methods utilize a chemical reaction called saponification, which is the hydrolysis of glyceride when reacted with a base (NaOH). It takes a fatty acid from a triglyceride and reacts with it with a strong base in the presence of water to produce glycerin and a carboxylic salt soap base. Our process will be utilizing a blend of three fatty acids (15% lauric acid, 25% palmitic acid, and 60% oleic acid), for the triglyceride, to produce solid bar soap with desired properties set forth in industrial literature.

The project goals are to exemplify caring, trust, and cultural appropriateness in our design, by offering a reliable, trustworthy, and relatively inexpensive soap option to the average family.

**Objectives**

- Design to produce roughly 1,000 kg of soap/hr
- Design of process equipment
  - Continuously stirred-tank reactor (CSTR)
  - Tank sizing
  - Pump and equipment energy estimation
- Design a high-quality soap in terms of:
  - Hardness
  - Cleansing
  - Conditioning
  - Bubbly lather
  - Creamy lather
- Meeting all requirements and regulations
  - Government requirements
  - Environmental requirements
  - Performance requirements
- Safety
  - Environmental
  - Process
  - Consumer

**Chemistry**

\[
\text{Triglyceride} + 3 \text{NaOH} \rightarrow \text{Carboxylic Salts} + \text{Glycerin}
\]

**Figure 1:** Saponification Reaction

- 15% Lauric Acid
- 25% Palmitic Acid
- 60% Oleic Acid

**Figure 2:** Fatty Acids for Triglyceride

**Process Overview**

- A composition of glycerin and fatty acids enter the conversion reactor (Reactor 1) to form JAGS triglyceride.
- NaOH in water, along with JAGS triglyceride, enter the CSTR reactor (Reactor 2).
- A liquid solution exits the CSTR reactor and enters a separator, separating the liquid carboxylic salts (soap base) and glycerin. This glycerin is recycled back into the system.
- Carboxylic salts, with water, are mixed with scented enzymes to give the product a fragrance.
- Liquid soap is then cooled to a solid soap to be cut into bars.

**Figure 3:** Process Flow Diagram for JAGS Soap Production

**Conclusions**

- The process was successfully designed and modeled using Excel and UniSim software.
- The soap mixture developed fell within industrial literature recommendations for all qualities.
- The plant construction, operation, and product are in accordance with local and federal regulations.
- The business model’s viability is demonstrated in a 5-year return on investment.
- JAGS Soap met all objectives and requirements for their personal project scope, Engr340, and the industry.

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